

# American Potato Journal

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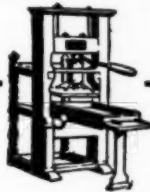
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## NEW DEVELOPMENTS IN FERTILIZERS

In recent years the potato grower has seen many changes in our knowledge concerning the kind and amount of fertilizer to use for the most economical production of the crop. These changes have come about largely through the results of experiments conducted by Experiment Station workers in the different potato growing states. In the eastern states it has been conclusively demonstrated that best returns follow heavy applications of a high analysis fertilizer. The common practice in many sections is to use a 5-8-7 mixture at the rate of a ton per acre. In more recent years it has been shown that good results follow the use of concentrated fertilizers so that many growers are now using a 10-16-14 mixture at the rate of 1000 pounds per acre.

With the introduction of the higher analysis fertilizer mixtures more attention has been given to the proper location of the fertilizer in relation to the seed piece. The results of extensive experiments have shown conclusively that largest returns are likely to follow where the fertilizer is placed approximately 2 inches to the side and either on the same level or slightly below the seed piece.

More recently the potato specialist has been interested in the value of the so-called rarer elements in a fertilizer for potatoes. In this issue of the JOURNAL, R. L. Carolus discusses results obtained following the addition of magnesium to a potato fertilizer under Virginia conditions. His results and those reported from other states suggest the importance of knowing more concerning the nutrition of the potato than is now the case. They suggest also that the potato grower must watch his soils carefully if he is to get maximum returns from the crop.

We have learned much concerning the use of potato fertilizers in recent years. It is possible that the present inquiries into the value of the rarer elements may lead to even more interesting developments.

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## SOME SIGNIFICANT VARIATIONS IN THE CHEMICAL COMPOSITION OF THE PLANT ASSOCIATED WITH A MALNUTRITION TROUBLE OF POTATOES<sup>1</sup>

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### INTRODUCTION

Virginia ranks first among the states in the production of early potatoes. The industry is centered in the eastern part of the state. There has been a marked decrease in the acre yield of potatoes in this section during the past six years. The following table compiled from the 1932 Yearbook of Agriculture shows this downward trend with comparative data for other sections.

*Potato yield per acre (in bushels per acre)*

	1927	1928	1929	1930	1931
Virginia .....	161	156	148	117	120
South Atlantic Section .....	124	128	121	98	111
United States .....	117	123	111	110	111

The marked decrease in production recorded for 1930 was due to the prolonged drought that occurred that year. It should be noted that, while the average acre increase in production for the south Atlantic states for 1931 over that for 1930 was 13.5%, Virginia's increase for 1931 was only 2.6%. The 1931 acre yield for Virginia was 16% less than it was in 1929, while for the south Atlantic section a decrease of only 8% was noted, and for the country as a whole no reduction was recorded. For 1932 preliminary reports indicate that Virginia has suffered another marked reduction in yield per acre.

<sup>1</sup> This work was the outcome of a survey of the potato malnutrition trouble in eastern Virginia, 1931, made by B. E. Brown, of the Bureau of Chem. and Soils, U. S. Dept. of Agriculture, and H. H. Zimmerley, of the Virginia Truck Experiment Station. These agencies are conducting cooperative investigations in Virginia as a part of a general study in several states to determine the influence of magnesium on development and production of the potato on prominent soil types. A complete write-up of the data for all sections will include salient analytical data herein presented as a contribution of the Virginia Truck Experiment Station.

The figures in Table 1 give the rainfall at the Experiment Station for bi-monthly periods for the first six months of 1930, 1931, and 1932, with the fifty year monthly mean for comparison. Totals for the six

TABLE 1.—Rainfall data—Diamond Springs, Va.

Period	1930	1931	1932	50-Year Mean
	<i>in.</i>	<i>in.</i>	<i>in.</i>	<i>in.</i>
Jan. 1-15 .....	1.25	1.60	3.91	3.25
Jan. 16-31 .....	2.40	.30	1.05	
Feb. 1-14 .....	2.00	1.27	2.42	3.30
Feb. 15-28 .....	.30	1.35	1.00	
Mar. 1-15 .....	1.10	1.65	1.90	4.02
Mar. 15-31 .....	1.50	2.83	1.05	
Apr. 1-15 .....	1.90	3.39	2.20	3.40
Apr. 15-30 .....	1.07	1.10	.60	
May 1-15 .....	.25	4.79	2.00	3.63
May 15-31 .....	1.88	2.22	.10	
June 1-15 .....	4.12	1.53	2.37	4.09
June 15-30 .....	.70	2.95	2.34	
Total Jan. 1-June 30 .....	20.69	24.98	20.94	21.69
% of Mean Jan. 1-June 30 ..	95.4%	115%	96.5%	100%
Total Mar. 15-May 15 .....	4.72	10.11	5.85	7.23
% of Mean Mar. 15-May 15 ..	65.3%	140%	80.8%	100%

month period indicate a slight deficiency for 1930 and 1932, and an excess for 1931. When the rainfall for the period from March 15 to May 15 is computed, a marked deficiency in 1930 and a significant shortage in 1932 are noted. In 1931 a 40% excess was recorded for this two month period. The period March 15 to May 15 was selected because these two months are deemed the critical period in the aerial growth of the potato plant in this section.

The high temperatures prevailing throughout the entire growing season of 1930 accompanied by a marked deficiency in the rainfall resulted in an extremely poor growth of vegetation in this section of Virginia. The poor coverage of the ground and the high temperature facilitated the rapid oxidation of the organic matter content of the soil. Therefore, the 1931 crops were grown on soils that, due to lack of vegetative growth in 1930 and the oxidation of organic matter during the

same year, probably contained a lower percentage of organic matter in their composition than at any other time in recent years. In this connection it might be well to state that the organic matter content of the soils in many fields in this section of Virginia had been allowed to become low during the last ten years due to the prohibitive cost of stable manure and the continuous production of cash crops.

#### DESCRIPTION OF THE MALADY

Poor growth accompanied by a yellowing of the leaves of the plant was first reported on May 1, 1931. This injury was most severe in certain definite areas of the fields examined. Within a week after a period of exceptionally low temperature and abundant rainfall, a number of other potato growers complained of a similar disturbance in plant growth. Soil samples taken under yellowing plants and under adjacent healthy ones, showed a slightly more acid soil condition to be associated with the poor growth. These yellowed plants failed to grow to any extent during a four week period from May 1 to June 1. The lower leaves and especially the apical leaflets yellowed from the margin toward the midrib. The new terminal growth consisted of small, half closed, purplish gray leaves. The stems were small in cross-section and were also purplish gray in color. By the middle of May this trouble was wide-spread throughout the entire Virginia section, about 10% to 15% of the acreage being affected by this yellowing. A detailed survey of over one hundred fields, sixty of which showed this trouble, was made the last week in May. No relation between fertilizer treatment, either brand or method of application, and this trouble was observed. Seed source was also eliminated as a causal factor. A high degree of correlation, between the practice of turning under organic matter and good growth was noted. The trouble was most prevalent on the lighter types of soil and injury was recorded throughout a pH range of 4.1 to 7.0. Elevated sections of a field and slopes were affected most severely. In no case was this trouble found on all sections of any field. This would lead to the conclusion that the soil in the entire area was becoming deficient in some property or properties needed in the production of optimum growth and that due to the natural heterogeneity of the soil, certain portions becoming devoid of these properties sooner than others gave rise to the spotty appearance of this trouble.

#### CHEMICAL STUDY OF PLANTS SHOWING SYMPTOMS OF MALNUTRITION DURING 1931

The climatic and edaphic factors associated with this trouble have been briefly discussed in the preceding sections. The nutritional disturbances occasioned by variation of one or the other or both of these factors will be indicated in part at least by the chemical composition of the aerial portion of the plant. Eight fields sampled at different intervals were selected in the study of this trouble during 1931.



Fields No. 1, 2, 7 and 8 showed injury to a marked degree early in May, about two weeks previous to the first plant sampling. The poor plants in all fields made some recovery during the latter part of the growing season, the newer leaves appearing to be almost normal in their development. A small tuber yield was realized from these plants. Injury to plants in fields No. 3, 4, 5, and 6 did not show up until late in May. The plants did not recover from this injury in time to set tubers of any size. The potatoes grown on all fields were the Irish Cobbler variety, planted between February 20 and March 1. The general fertilizer practice in this section, of applying at the time of planting about a ton of 7-6-5 mixture per acre, was followed on these fields. The soil types on which the fields were located were Norfolk sandy loam, Norfolk fine sandy loam, or Moyock fine sandy loam.

Ten yellowed and ten healthy plants carefully selected for their uniformity as to size and condition of growth were taken from each field to the laboratory. The aerial portion of the plant was sampled in its entirety from fields No. 1 to 4. In fields No. 5 to 8 the plants were divided into upper leaves, lower leaves and stems. Dry weight, total and reducing sugars, total polysaccharides and total and insoluble nitrogen were determined on duplicate fifty gram alcohol preserved samples as noted in a previous work. (1) Other determinations were made from 250 gram samples of oven dried tissue. Ash was determined as stated in Mahin and Carr, (11) calcium oxide and magnesium oxide by tentative methods six and seven from the official methods for plants. (13) Potassium oxide was determined by precipitation of the potassium by sodium cobalti-nitrite and then titrating the precipitate with potassium permanganate. Phosphorus was determined by the magnesium nitrate fusion method. Methods for both potassium and phosphorus were made applicable for this type of work by Dr. R. P. Thomas of the Department of Agronomy of the University of Maryland. The determination of soil acidity from both areas was made on samples of soil taken near the roots of the plants and found electrometrically with a quinhydrone electrode. Loss on ignition was determined on a 10 gram sample as given in the tentative official methods for soils. (13)

#### DISCUSSION OF RESULTS

The results of the 1931 analyses are found in Tables 1 and 2. In Table 2 the soil reaction figures show no consistent correlation with plant growth; but the organic matter content as indicated by loss on ignition is definitely associated with good development in the plants. When considering the reaction value of a soil it must be borne in mind that the pH value merely indicates the current acidity or alkalinity of a soil and that its potential base exchange capacity (or cation content) is determined to a great extent by the amount of inner phase



TABLE 2.—The relation of the variation in the composition of the early growth of good and poor potato plants to the soil condition under which they were found growing in 1931

Plant growth	Field No.*	Soil analysis		Plant analysis (percentage based on dry weight)											
				Soil** reac-tion	Loss on igni-tion	% Ash	% MgO	% CaO	% K <sub>2</sub> O	% P	% Dry wt.	% Reduc-ing sub-stances	% Total sugars	% Hydro-lyzable material	% Soluble nitrogen
Good	1-A	5.52	2.41%	12.77	0.373	1.56	6.40	.....	10.46	3.42	5.69	12.16	2.62	2.98	5.60
Poor		4.79	1.40	8.60	0.114	0.57	4.70	.....	12.57	8.40	13.08	10.04	1.73	2.52	4.25
Ratio G/P		1.72	1.49	3.27	2.74	1.36	.....	0.833	0.407	0.411	1.22	1.52	1.18	1.32	
Good	2-A	5.01	4.85	15.65	0.365	1.41	6.92	.....	9.32	3.34	6.55	10.35	4.03	3.07	7.04
Poor		5.27	1.95	11.82	0.177	0.77	6.36	.....	11.35	6.87	11.68	11.58	1.73	2.67	4.40
Ratio G/P		2.49	1.32	2.10	1.83	1.09	.....	0.822	0.486	0.561	0.895	2.33	1.15	1.60	
Good	3-B	5.84	2.65	16.92	0.480	1.92	7.69	0.513	12.13	3.63	7.67	13.34	1.66	2.82	4.48
Poor		6.18	1.77	14.07	0.108	1.88	6.45	0.560	13.18	6.35	11.56	9.89	0.96	1.94	2.90
Ratio G/P		1.50	1.21	4.63	1.02	1.19	0.916	0.923	0.572	0.566	1.35	1.73	1.45	1.54	
Good	4-B	5.84	3.80	14.08	0.380	3.44	5.28	0.376	12.57	5.45	10.35	11.17	1.39	2.57	3.96
Poor		7.03	2.84	15.77	0.191	3.91	5.83	0.280	12.84	9.20	15.35	10.62	0.85	1.65	2.50
Ratio G/P		1.34	0.89	1.99	0.88	0.91	1.34	0.980	0.593	0.675	1.05	1.64	1.56	1.58	
Mean Ratio Good/Poor			1.76	1.23	3.00	1.62	1.14	1.13	0.890	0.515	0.553	1.13	1.81	1.36	1.51

\* Fields lettered A were sampled May 14; B, May 29.

\*\* Expressed in terms of pH value.

colloid that it contains. McGeorge (12) has emphasized the important function that organic matter, a part of the inner phase colloid, plays in altering this capacity. Therefore, under the conditions involved in this work, the acidity of the soil on which healthy and injured plants were found can best be understood in relation to the soil's organic matter content. The ratio of the amount of organic matter (determined and expressed as loss on ignition) found in the soil on which poor plants were growing is shown for each field. In the explanation of the results obtained the ratio of the content of organic matter found under good growing conditions and compared with a similar content found under poor growing conditions has been designed as the Good/Poor ratio. The mean Good/Poor ratio of organic matter, for the four fields is 1.76, which indicates that on an average good plants were found growing in soils in which the organic matter content was 1.76 times as large as the soils on which the poorer plants were growing.

The mean Good/Poor ratios of the ash, MgO, CaO, K<sub>2</sub>O and P content of the plants are all greater than one, thus indicating an increased intake of these elements in the plants making the better growth. The Good/Poor ash, CaO and K<sub>2</sub>O ratios are widest in field No. 1-A, the one field in which the poor plants were produced under conditions of both high acidity and low organic matter content. In field No. 2-A one would expect to find a much higher available calcium, magnesium and potassium content in the soil on which good plants were produced, even though the good growth was made on a soil of pH 5.01 and the poorer growth on a soil of pH 5.27, because of the higher organic matter content of the good area as indicated by a Good/Poor ratio of 2.49. This presumption was verified by the relative intake of these elements by the good and poor plants of this field. In field No. 4-B where poor plants were produced on a soil with a higher reaction value than that on which the good plants were found and a comparatively high organic matter content, the Good/Poor ratios of ash, CaO, and K<sub>2</sub>O were slightly less than unity, indicating a greater intake of these substances by the poorer plants.

The difference in the MgO content was the most significant result obtained in the ash analysis of the good and poor plants from the first four fields. The Good/Poor ratio of MgO in plants was never less than 1.99, was as large as 4.63 and gave a mean of 3.00. These large ratios would indicate that a deficiency of magnesium in the plant was an associated, if not the causal factor, in the arrested development and yellowing of some plants.

Garner and others (3) determined that a chlorosis of tobacco, which they named sand drown, was due to lack of magnesium in the plant. They found that sulphur compounds in the form of sulphate of ammonia aggravated the trouble but that organic matter, in as small an amount as 500 pounds of cotton seed meal per acre exhibited some

preventive action against the trouble. Jones (6) found a chlorosis in corn, also due to a deficiency of magnesium in the plant tissue. He concluded from his work that the trouble was most prevalent on light leachy soil on which concentrated chemical fertilizers free from magnesium were used. Continuous cropping without additions of manure was paramount in causing this trouble. Lyon and Bizzell (10) found that as much as 41 pounds of magnesium were leached from planted soils on which the crops utilized only 7 pounds. On unplanted soils as much as 63 pounds were leached away annually.

The observations of the above mentioned workers are in good agreement with the results noted in this work. A rainfall of 4.70 inches from May 1 to 15 initiated this trouble and increased its severity on light leachy soils. Large amounts of concentrated chemical fertilizers with a large part of their nitrogen content from sulphate of ammonia are in general use in this section. Continued cropping with little or no use of organic matter has probably been responsible for the loss of many pounds of available magnesium through leaching. The facts suggest that bulkier fertilizers containing less nitrogen in the sulphate and more in the organic form would aid materially in checking this trouble and also in preventing part of the excessive loss of magnesium from leaching. The great increase in the magnesium content of the good plants, growing on soil higher in organic matter than that on which the poor plants were found, substantiates this statement. The problem of the magnesium content of the soil is not primarily one of supply but is one of keeping the soluble, leachable portion available for plant use when it is vitally essential for development.

The absorption of calcium by potato plants is influenced to a large degree by the availability of the element in the soil, as indicated by the pH reaction. In the poor plants, in field No. 4-B, growing on a soil with a reaction of 7.03 we find the maximum CaO content (3.91%), while in the poor plants in field No. 1-A growing on a soil with a pH of 4.79 we find the minimum CaO content (0.57%). No definite relationship between the CaO/MgO content of plants and growth was found. In field No. 1-A approximately the same ratio CaO/MgO was found in both good and poor plants but in field No. 4-B a much smaller ratio is found in the good plants than that observed in the poor ones.

True (15) believes the significance of the calcium ion in plants is to make the other ions physiologically available to the plant. He, too, could find no evidence of a definite CaO/MgO ratio in plants. However, he states that a certain quantity of calcium ions must be present in the medium for the maintenance of the chemical and functional integrity of the cell wall, as well as the chemical and functional integrity of the deeper lying living parts of the cells of absorbing roots

of higher green plants. Hobart (5) states that the function of calcium in plant nutrition is for protoplasmic stimulation and compares its function with that of the complex endocrine secretions of the higher animals.

In fields No. 1-A and 2-A the absence of calcium in the plant may be in part responsible for lack of growth in the poor plants; but lack of calcium is certainly not a contributing factor to stunting in fields No. 3-B and 4-B. This may help explain the fact that fields No. 1-A and 2-A yellowed several weeks previous to fields No. 3-B and 4-B. It would seem that lack of both calcium and magnesium is more quickly manifested in the physical appearance of the plant than is the lack of magnesium alone. However, it is clear that the calcium ion even in great abundance cannot permanently compensate for the lack of the magnesium ion in the plant.

Potassium is quite abundant in both good and poor plants from all fields. It would seem that it is of no significance in locating the seat of the trouble. The absorption of large amounts of CaO, as shown in the plants in field No. 4-A, tends to decrease the amount of potassium absorbed by the same plant. The converse, that is, the low calcium absorption would stimulate potassium absorption, is not true as shown in field No. 1-A. However, this lack of absorption in field No. 1-A may be due to the lack of potassium in the soil.

Phosphorus determinations on plants in fields No. 3-B and 4-B indicate a lack of absorption of that element when the soil is alkaline enough to facilitate the intake of large amounts of calcium by the plant.

Alcohol samples were analyzed to show the effect of the differential intake of mineral elements by the plant on the metabolism of the carbohydrate and nitrogenous compounds in the plant. The total volume of metabolic activity is much less in the poor plants than in the healthy ones, not only due to the lack of chlorophyll in their leaves but also due to their lack of photosynthetic area. The simple compounds of metabolism *i.e.*, reducing and total sugars are found more abundantly in the poor plants per unit dry weight. Their relative accumulation in poor plants is a criterion of the lack of development of growth in which they would have been utilized. The lack of magnesium in the chlorophyll molecule for the development of these compounds was evidently not as serious a factor as its lack in facilitating sugar utilization in growth or to facilitate sugar translocation to the storage portions in the tubers of the plant. The mean ratios for both reducing and total sugars indicate a sugar content almost twice as great in the poor plants as that found in the healthy ones.

The lack of available nitrogen for absorption by the poor plants is indicated in a high Good/Poor ratio for soluble nitrogen in all four fields. The relatively smaller Good/Poor ratio for insoluble nitrogen

indicates that the lack of nitrates was not as pronounced at some previous stage in the growth of the plant as at the time of sampling. An abundance of organic matter in the soil on which the good plants were growing was probably responsible for the larger amount of nitrogen found in these plants, the organic matter checking the excessive leaching of this element during the exceedingly rainy period early in May.

Table 3 shows the utilization of some of the mineral constituents by various parts of the plant. The plants in fields No. 5-B and 6-B became chlorotic at about the same time as those in fields No. 3-B and 4-B. Fields No. 7-C and 8-C showed the early yellowing noted in fields No. 1-A and 2-A. A most remarkable increase in the MgO content in the upper leaves of the poor plants of fields No. 7-C and 8-C was found. The increase in the magnesium content of these leaves has been due partly to utilization of the cation from the lower leaves, but mainly to a renewed and increased absorption from the soil. As these plants were sampled late in the season the absence of heavy rain during the preceding two weeks probably was responsible for the presence of more magnesium in the soil available for absorption. There is a decided increase in magnesium in all the upper leaves irrespective of the plant's condition over that in the older lower leaves.

The calcium content, however, was more abundant in the lower leaves than in the upper portions of the plant in the case of both good and poor plants. A most significant accumulation of the Ca ion occurred in the stems of the poor plants, which might suggest that some factor is interfering with its translocation. Potassium tends to accumulate most abundantly in the lower leaves and stems and so like calcium does not seem to be of as fundamental importance to the initiation of new growth as magnesium.

Wide variations are observed in the total nitrogen content of plants taken from fields No. 5-B and 6-B when compared with those from fields No. 7-C and 8-C. The trend in the nitrogen composition is of about the same order as that of the magnesium content of the plant, which suggest that the same factors that facilitate magnesium intake also increase nitrogen absorption. It is obvious, from the figures on the nitrogen content of the upper leaves of both good and poor plants from fields No. 7-C and 8-C, that these plants were resuming growth. The Good/Poor ratios for both fields indicate an even more rapid intake of nitrates by the poor plants than by the healthy ones. This might be explained by a depressing effect of cold rainy weather on nitrification and then an accelerated resumption with the advent of more favorable conditions. Another explanation might be found in the accentuated leaching of the nitrates during this earlier period of rainy weather. It is also likely that relatively slow synthesis of the soluble nitrogen into the more complex organic forms was partly responsible for the accumulation of soluble nitrogen in the poor plants.



TABLE 3.—*The variation in the distribution of some of the ash constituents in good and poor potato plants found growing under varying soil conditions during 1931. (Percentage based on dry weight of plants.)*

Plant growth	Field No.*	Soil** reaction	% Loss on ignition	*** % Ash			% MgO		
				U.L.	L.L.	S.	U.L.	L.L.	S.
Fair .....	5-B	4.56	2.55	11.7	8.6	15.8	0.383	0.264	0.271
Poor .....		6.19	2.25	11.9	13.8	17.1	0.202	0.166	0.228
Ratio F/P			1.13	0.985	0.624	0.925	1.90	1.59	1.19
Good .....	6-B	5.84	2.89	13.6	20.1	20.1	0.405	0.416	0.275
Poor .....		5.67	1.86	13.6	11.3	17.9	0.320	0.206	0.224
Ratio G/P			1.55	1.00	1.78	1.12	1.27	2.00	1.23
Good .....	7-C	5.52	2.41	13.0	16.7	.....	0.460	0.380	.....
Poor .....		4.79	1.40	13.1	11.8	.....	0.329	0.094	.....
Ratio G/P			1.72	0.993	1.42	.....	1.40	4.05	.....
Good .....	8-C	5.30	4.85	15.2	19.2	.....	0.492	0.354	.....
Poor .....		4.70	1.95	14.2	16.2	.....	0.362	0.072	.....
Ratio G/P			2.49	1.07	1.19	.....	1.36	4.92	.....
Mean Ratio Good/Poor .....			1.72	1.01	1.25	1.02	1.48	3.14	1.21

\* Fields lettered B were sampled May 29; C, June 6.

\*\* Expressed in terms of pH value.

\*\*\* U.L.—Upper leaves; L.L.—Lower leaves; S.—Stems.

#### EFFECT OF $MgSO_4$ TREATMENT ON THE COMPOSITION OF POTATO PLANTS IN 1932

Ecological conditions under which plants grow vary from year to year. In 1932 the conditions causing the malnutrition trouble in 1931 failed to appear over any wide-spread area. However, the abandonment of poor areas and the careful selection of fertile fields, by the planter, on which to grow his crop had some effect on the diminution of the trouble in 1932.

Samples of plant tissue were taken from six fields, only two of which showed marked yellowing and stunting in plant growth. Plants in field No. 9 developed symptoms of the 1931 type of injury as early as May 5. The trouble was manifested over a five acre area in which good and poor plants were found growing on adjacent rows. All plants in field No. 10, which adjoined field No. 9, made good growth. Fields No. 11 and 14 were selected for remedial treatment in 1932 because they had both shown injury in 1931. Field No. 11 was a very acid

poor  
ed on

S.	% CaO			% K <sub>2</sub> O			% P			% N		
	U.L.	L.L.	S.	U.L.	L.L.	S.	U.L.	L.L.	S.	U.L.	L.L.	S.
0.271	1.09	2.00	1.53	5.83	7.51	8.89	0.552	0.500	0.536	5.45	4.99	6.06
0.228	1.08	1.55	2.07	6.24	6.22	7.46	0.400	0.386	0.452	3.81	3.50	3.34
1.19	1.01	1.29	0.74	0.935	1.21	1.19	1.38	1.30	1.19	1.43	1.43	1.81
0.275	1.68	2.89	1.99	6.01	7.58	8.78	0.472	0.408	0.461	5.02	4.57	7.34
0.224	2.00	2.63	3.22	6.38	6.31	6.62	0.600	0.509	0.624	4.22	3.36	3.64
1.23	0.840	1.10	0.618	0.945	1.20	1.33	0.787	0.803	0.740	1.19	1.36	2.07
	1.67	3.03	.....	.....	6.19	.....	0.544	0.340	.....	7.62	6.34	.....
	1.06	1.40	.....	6.31	5.84	.....	0.568	0.368	.....	8.72	6.02	.....
	1.58	2.16	.....	.....	1.09	.....	0.957	0.925	.....	0.875	1.05	.....
	1.78	2.40	.....	7.01	7.74	.....	.....	.....	.....	7.46	6.70	.....
	1.89	1.99	.....	5.82	7.06	.....	.....	.....	.....	8.64	4.80	.....
	0.942	1.21	.....	1.21	1.10	.....	.....	.....	.....	0.865	1.40	.....
1.21	1.09	1.44	0.679	1.03	1.15	1.26	1.04	1.01	0.965	1.09	1.31	1.94

area high in organic matter; field No. 14 was a fairly acid soil low in organic matter. Several areas in both fields were treated with  $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$  at the rate of 65 pounds of  $\text{MgO}$  per acre. The material for this treatment was furnished by the Bureau of Chemistry and Soils of the U. S. Department of Agriculture. Certain areas in field No. 11 were also limed at the rate of 1000 pounds of hydrated material per acre. Plants on the untreated sections in field No. 11 yellowed to about the same degree as the entire field did in 1931. Magnesium sulfate treated portions grew very well and limed areas showed some improvement over untreated portions of the field. Growth responses were practically the same on both sections of field No. 14. Field No. 12 was selected for study because many scattered spots showed extremely poor plant development; however, no yellowing had been observed in this field at the time of sampling. Plants from field No. 13 probably were typical of the optimum growth of potatoes in this section for 1932 and were taken for analysis for the purpose of comparing good growth in a good field with good and poor growth in poor fields.



The potatoes were grown in the same way as indicated for 1931. Methods of sampling and analysis were identical with those practiced in 1931, with the exception that upper and lower stems and roots were sampled separately in some cases in 1932. Colorimetric determinations of iron, according to the method suggested by Schreiner and Failyer (14), and gravimetric determinations of aluminum as outlined by Mahin and Carr (11) were added to the list of mineral elements found in 1932.

TABLE 4.—*A comparison of the chemical composition of normal potato plants with that of treated and untreated plants showing symptoms of malnutrition in 1932. (All percentages, except that of dry weight, are based on the dry weight of the plant)*

Field No.	9				10	
Date of sampling	May 16		May 27		5/16	5/27
Growth or treatment*	F.	V. P.	F.	V. P.	G.	G.
Weight of average plant (gms.)	190	94	278	86	225	286
Soil reaction (pH value)	4.20	4.35	4.51	4.5	4.6	4.6
Per cent loss on ignition	4.30	2.00	3.76	2.68	3.85	3.85
Plant ash analysis:						
% Ash	19.5	23.1	20.9	23.5	18.7	15.96
% MgO	0.37	0.19	0.482	0.376	0.23	0.47
Mgs. of MgO per plant	75	17	119	30	54	120
% CaO	1.35	0.986	1.35	1.19	1.63	1.98
% K <sub>2</sub> O	7.36	6.91	8.60	7.38	6.83	6.52
% P	0.64	1.01	0.608	0.868	0.55	0.546
% Fe	0.083	0.115	0.043	0.087	0.071	0.037
% Al	0.133	0.188	0.074	0.153	0.172	0.055
Plant tissue analysis:						
% Dry weight	8.73	8.34	8.76	10.47	9.33	8.88
% Reducing substances	7.20	7.16	8.16	8.54	6.62	9.20
% Sucrose	7.33	7.18	4.09	5.46	7.68	5.56
% Total sugars	14.53	14.34	12.25	14.00	14.30	14.76
% Polysaccharides	9.24	8.79	8.00	7.05	10.26	8.32
% Total carbohydrates	23.77	23.13	20.25	21.05	24.56	23.08
% Soluble nitrogen	1.18	1.22	1.36	1.36	0.77	1.31
% Insoluble nitrogen	4.48	4.56	4.18	4.22	4.19	4.21
% Total nitrogen	5.66	5.78	5.54	5.58	4.96	5.52
Ratio C/N	4.2	4.02	4.07	3.78	4.95	4.17

\* F.—Fair growth. G.—Good growth. V. G.—Very good growth. V. P.—Very poor growth. P.—Poor growth.

#### DISCUSSION OF RESULTS

The results of the 1932 analyses are found in Table 4 and 5. In Table 4 comparisons are made between the chemical composition of good and poor plants grown on poor areas with good plants grown on good areas and between the above mentioned plants and those grown on magnesium sulfate and limed areas. To avoid repetition only the significant facts that were not brought out in the discussion of the 1931 results will be noted. The injury occurred only on the acid soils dur-

ing 1932, and the lack of organic matter did not play as important a part in its occurrence as in 1931. As the potato plants experienced a particularly rainy period during their growth in 1931 and a rather dry period during 1932, the inference would be drawn that during 1932 leaching was mainly responsible for the lack of magnesium and that in 1932 unavailability of some element on highly acid soils was responsible for the lack of good growth, the symptoms again suggesting magnesium deficiency.

11						12		13
May 16			May 27			5/16		5/27
MgSO <sub>4</sub>	Lime	Check	MgSO	Lime	Check	G.	P.	V. G.
166	131	84	198	149	87	225	56	264
4.2	4.4	4.2	4.2	4.4	4.2	5.2	4.9	5.1
5.43	5.60	5.88	5.43	5.60	5.88	1.67	1.42	3.30
16.3	15.1	14.8	17.4	17.6	17.1	19.5	20.1	17.3
0.34	0.13	0.12	0.494	0.30	0.21	0.35	0.31	0.66
67	19	12	91	60	20	81	22	204
0.85	0.91	0.77	1.01	1.42	1.03	2.18	2.19	2.67
7.14	5.79	5.94	7.93	7.63	7.60	6.06	5.83	6.10
0.48	0.44	0.49	0.40	0.41	0.38	0.58	0.58	0.447
0.066	0.059	0.085	0.040	0.040	0.049	0.084	0.108	0.039
0.130	0.108	0.170	0.100	0.112	0.083	0.119	0.167	0.149
10.40	10.17	11.08	10.13	12.22	11.38	10.43	11.65	10.7
4.30	14.47	14.41	8.94	8.73	9.28	6.71	3.98	14.22
7.82	8.92	10.38	6.26	7.18	8.27	5.86	5.82	7.22
12.12	23.39	24.79	15.20	15.91	17.55	12.57	9.80	21.44
9.83	10.81	10.75	8.56	7.70	7.95	8.82	7.73	9.47
21.95	34.20	35.54	23.76	23.61	25.50	21.39	17.53	30.91
0.99	1.56	1.33	1.18	1.09	1.27	1.19	1.24	1.21
4.88	4.01	4.15	4.40	4.46	4.48	4.54	4.86	3.44
5.87	5.57	5.48	5.58	5.45	5.75	5.73	6.10	4.65
3.74	6.15	6.49	4.26	4.34	4.44	3.73	2.88	6.66

In field No. 9, low acidity accompanied by low organic matter content in the soil produced poor growth as indicated by the average plant weight. At the May 27 sampling, and again to a lesser extent eleven days later, a large deficiency in magnesium and also smaller percentages of calcium and potassium were found in the stunted plants. However, the absorption of phosphorus, iron and aluminum was accentuated in the poorer plants. Gericke (4) in a report of a study, "Magnesia Injury" of plants grown in nutrient solutions, found that

TABLE 5.—*Malnutrition in potato plants: The effects of magnesium sulfate treatment on the distribution of some of the ash constituents of the plant. (Percentage based on dry weight of plants sampled)*

Treatment	MgSO					
Part of plant*	U. L.	L. L.	U. S.	L. S.	R.	U. L.
Field No. 11						
Average weight of plant part (gms.)	26	25	21	55	9	12
Soil reaction (pH value)	4.05	.....	.....	.....	.....	3.95
Per cent loss on ignition	5.98	.....	.....	.....	.....	5.95
Plant ash analysis:						
% Ash	15.2	25.2	24.3	24.5	15.9	14.1
% MgO	0.44	0.25	0.46	0.78	0.20	0.23
% CaO	1.13	1.11	1.26	1.32	1.64	0.89
% K <sub>2</sub> O	3.86	4.44	9.99	9.93	2.51	4.06
% P	0.292	0.301	0.211	0.155	0.348	0.322
% Fe	0.068	0.167	0.101	0.078	0.170	0.075
% Al	0.142	0.429	0.097	0.117	0.195	0.146
Field No. 14						
Average weight of plant part (gms.)	27	33	17	42	7	52
Soil reaction (pH value)	4.55	.....	.....	.....	.....	4.55
Per cent loss on ignition	2.45	.....	.....	.....	.....	2.88
Plant ash analysis:						
% Ash	16.2	24.4	23.6	24.4	12.7	19.8
% MgO	0.68	0.64	0.53	0.94	0.30	0.35
% CaO	2.80	3.04	3.68	3.86	1.06	3.42
% K <sub>2</sub> O	3.76	3.65	7.56	7.89	2.22	3.72
% P	0.369	0.339	0.386	0.298	0.442	0.356
% Fe	0.066	0.114	.....	0.267	0.068	0.080
% Al	0.080	0.307	.....	0.212	0.177	0.170

\* U. L.—Upper leaves. L. L.—Lower leaves. U. S.—Upper stems. L. S.—Lower stems. R.—Roots.

under certain conditions the addition of phosphate salts proved beneficial to growth in solutions that were toxic due to excessive concentrations of magnesium. Lutman (9) noted that a low phosphorus content in the culture solution led to a high magnesium content in the plant ash. If, then, an abundance of available phosphate in the absorbing medium prevented toxicity due to excessive magnesium, might not the inference be drawn that a high amount of phosphorus in the plant interfered with the absorption and proper metabolism of magnesium. It would appear that the magnesium/phosphorus relationship found in the plants from field No. 9 is of some physiological importance. Jones (6) found the iron and aluminum content of corn was greater in healthy than in chlorotic plants; this relationship was not found in the potato, the exact opposite effect being noted in the plants from field No. 9. An examination of the carbohydrate and nitrogen content of both good and poor plants, in field No. 9, indicates no appreciable dif-

Untreated				Limed				
L. L.	U. S.	L. S.	R.	U. L.	L. L.	U. S.	L. S.	R.
7	9	26	5	25	26	20	59	9
.....	.....	.....	.....	4.25	.....	.....	.....	.....
.....	.....	.....	.....	5.97	.....	.....	.....	.....
23.6	24.2	23.5	13.2	16.5	25.6	21.1	22.0	12.1
0.13	0.16	0.27	0.14	0.20	0.10	0.17	0.29	0.11
0.85	1.58	1.93	1.02	1.15	0.93	1.72	2.16	0.87
4.00	9.27	9.27	2.80	4.12	4.75	9.55	9.08	2.48
0.318	.....	0.275	0.206	0.228	0.198	0.159	0.142	0.163
0.167	0.079	0.104	0.114	0.092	0.137	0.065	0.109	0.115
0.350	.....	0.179	.....	0.234	0.497	0.108	0.095	0.340
36	37	53	10					
.....	.....	.....	.....					
.....	.....	.....	.....					
28.0	26.2	26.2	13.0					
0.13	0.31	0.40	0.32					
3.71	4.52	4.81	1.09					
3.72	8.39	7.54	2.70					
0.324	0.318	0.266	0.258					
0.115	0.110	0.053	0.155					
.....	0.141	0.100	0.283					

ference in the composition of good and poor plants. The abundance of nitrogen in both good and poor plants helps substantiate the contention that poor growth on this field is not due to the leaching of available magnesium but is due to the unavailability of this ion to plant growth occasioned by the acidity of the soil. In the good plants grown in field No. 10, which adjoined field No.9, a higher pH reaction accompanied by a larger organic matter content was associated with an increase in the magnesium and calcium content and a decrease in the potassium, phosphorus, iron and aluminum content in the plant.

In field No. 11 the effect of magnesium application on the magnesium content of the plant is strikingly shown at the earlier sampling period and to a lesser extent on May 27. Plants harvested from the limed areas indicated that lime gave little stimulus to the absorption of magnesium by the plant at the earlier sampling period. However, by the time of the latter sampling a 50% increase, over the check, in

the magnesium content of the plants grown on the limed area, showed that lime produced a marked but delayed effect when applied immediately prior to planting.

The calcium/magnesium ratio in the plant grown on the magnesium treated area averaged only 2.25 while in most other cases in both years, irrespective of the growth of the plant, the ratio was greater than 4. This further substantiates the experimental evidence of other workers (7, 9, 15) who also found no definite calcium/magnesium ratio associated with good growth. A marked increase in the absorption of calcium at the latter sampling date by the plants on the limed area indicates that its effect on its own absorption is similar to its effect on the absorption of the magnesium ion.

The effect of these treatments on the metabolism of the plant is also noteworthy. At the earlier sampling period the relatively large accumulation of reducing substances in the plants on the limed and check areas, indicating a lack of translocation to the storage tissue, is probably the ultimate reason for the lack of yield on these portions of the field. At the May 27 sampling an additional intake of magnesium by these same plants is associated with the clearing up of this nutritional disturbance as indicated by a uniform percentage of reducing substances in the plants from all three areas.

In field No. 12, where poor growth but no yellowing occurred, no marked deficiency in the magnesium content was found. However, some other factor is interfering with metabolism as indicated by the lower sugar content in the poor plants.

As the optimum growth of foliage occurred, and a high yield of tubers was harvested on field No. 13, the composition of plants grown under these ideal conditions should prove especially interesting for comparative purposes. A soil reaction of pH 5.1 and an organic matter content of 3.3% are generally considered as being within the optimum range for good growth. The plants contained 0.66%, or 204 milligrams, of MgO per plant. This content is much higher than that found in any of the good plants growing in fields in which poor growth also occurred. Therefore, in this case, an abundant supply of magnesium was necessarily present in the soil in an available form for plant utilization. The calcium content is high due to the high soil reaction, and the potassium content is low due to the presence of an abundance of calcium in the plant. Phosphorus and iron are present in relatively optimum amounts but aluminum is found in comparatively great abundance.

A study of the effect of this supposedly optimum mineral content on the metabolism of the plant indicates some of the factors that were paramount in producing the high yield. First of all it should be kept in mind that the size of the plant necessarily resulted in a large photosynthetic area in which to elaborate the simple carbohydrate com-

pounds. We find an exceptionally high reducing substance content in these plants, it being as large as that found in the yellowed plants growing in the absence of an abundance of magnesium. However, the exceptional vigor of the plants and their subsequent large yield, preclude the possibility of faulty translocation. Therefore, we conclude that very good plants due to an optimum metabolistic efficiency accumulate at least during the day the primary products of photosynthesis in their aerial portions. The lack of an accumulation of sucrose and polysaccharides indicates a functioning translocation system. Therefore, a high carbohydrate/nitrogen ratio is not indicative of malnutrition unless accompanied by low yield.

The amounts of the ash constituents found in the various portions of the plant, in Table 5, show to some extent the function and abundance of these materials in the plant. The samples were taken June 23, after all growth had practically ceased. In both fields serious yellowing had appeared in 1931 but trouble was apparent during 1932 only on field No. 11. The magnesium content in plants from both treated and untreated sections is higher in field No. 14 than in field No. 11, indicating greater availability of the Mg ion in the soil in the former field. As the soil reaction of field No. 14 is considerably higher than that of field No. 11, it may be safe to assume that low acidity, influencing the availability of the magnesium ion to plant growth, was the cause of yellowing in field No. 11. Then under normal conditions of rainfall, yellowing due to lack of magnesium, may be associated with a lack of this ion in the soil in an available form for plant utilization. However, when excessive moisture conditions are prevalent, as was the case in 1931, a large organic matter content in the soil is vitally necessary to maintain the supply of available magnesium for plant development.

The relative abundance of magnesium, and the relative lack of calcium and potassium in the upper leaves as compared with the lower leaves show that magnesium is the most essential of the three elements to new growth and development in potato plants. Iron and aluminum were both more abundant in the lower than in the upper portions of the plant. The aluminum content of the roots also became quite large in the plants grown on soil on which magnesium sulfate had not been applied.

#### CONCLUSION

Magnesium was shown, by chemical analysis of plants showing injury due to lack of some essential mineral element, to be of vital importance for plant growth. The result of a deficiency of magnesium, under various soil conditions, on the maladjustment of the organic and inorganic constituents was demonstrated and explained. Under conditions of excessive rainfall the available magnesium content of the soil is readily depleted by leaching, unless the soil contains in its inter-



nal colloidal phase an abundance of organic matter. Under any condition, excessive acidity, interfering with the availability of the magnesium ion for plant absorption may cause yellowing and poor growth. We, then recognize two soil conditions under which magnesium would become the limiting factor for plant growth.

1. Lack of the element due to excessive leaching. A sixty barrel crop of tubers will remove from three to four pounds of magnesium and the plants producing it will utilize 3.6 pounds of the element. To insure that this amount will be available for absorption it should be included in the fertilizer mixture that is used in periods of abundant rainfall on light leachy soils. Chucka (2) reported increases as high as 155 bushels per acre on certain Maine soils that were treated with 300 pounds of  $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$  per acre. The turning under of organic matter will also prevent excessive leaching of magnesium.

2. Unavailability of magnesium on acid soils. The plant analyses show that even small amounts of lime increase the absorption of magnesium. Lipman and others' (8) records for a five-year period show a favorable increase in yield for magnesium limestone over that for other forms. On acid soils the addition of magnesium limestone, in quantities sufficient to bring the soil to a reaction of at least pH 5.0, supplemented while the soil is becoming adjusted to the increased calcium content with magnesium sulfate, should adjust this condition and facilitate plant growth.

Finally, then, the question of magnesium in soils is not primarily one of supply but one of keeping the amount already present in the soil in such a state that its absorption by the plant may be accomplished during the active period of crop growth.

#### LITERATURE CITED

1. CAROLUS, R. L. Effect of seasonal temperatures on chemical composition of kale. *Proc. Amer. Soc. Hort. Sci.* 27: 502. 1930.
2. CHUCKA, J. A. Magnesium. *Better Crops with Plant Food*. Feb.-March, 1932.
3. GARNER, W. W., McMURTREY, J. E., BACON, C. W., MOSS, E. G. Sand Drown, a chlorosis of tobacco due to magnesium deficiency and the relation of sulphates and chlorides of potassium to the disease. *Jour. Agr. Res.* 23: 27-40. 1923.
4. GERICKE, W. F. "Magnesia Injury" of plants grown in nutrient solutions. *Bot. Gaz.* 74: 110-113. 1922.
5. HOBART, F. G. Calcium in plant metabolism. *Bot. Abst.* 14: 569. 1925.
6. JONES, J. P. Deficiency of magnesium the cause of chlorosis in corn. *Jour. Agr. Res.* 39: 873-893. 1929.
7. JONES, R. L., and PEMBER, F. R. The fertilizer nutrients required by barley, wheat, and oats, as shown by both soil and water cultures. *Soil Sci.* 19: 169-199. 1925.
8. LIPMAN, J. G., BLAIR, A. W., McLEAN, H. C., and PRINCE, A. L. A comparison of magnesian and non-magnesian limestone in some 5-year rotations. *Soil Sci.* 15: 307-328. 1923.
9. LUTMAN, B. F., and WALBRIDGE, N. L. The rôle of magnesium in the aging of plants. *Vt. Agr. Exp. Sta. Bul.* 296. 1929.
10. LYON, T. L., BIZZELL, J. A., WILSON, B. D., and LELAND, E. W. Lysimeter experiments III. *Cornell Memoir* 134. 1930.



11. MAHIN, E. G., and CARR, R. H. Quantitative agricultural analysis. p. 145 (ash), p. 258 (aluminum).
12. McGEORGE, W. T. The base exchange property of organic matter in soils. Arizona Tech. Bul. 30. 1930.
13. Official and tentative methods of analysis. Assoc. of Official Agricultural Chemists, Washington, D. C. 1925. Ed. p. 21 (loss on ignition), p. 41-42 (calcium and magnesium).
14. SCHREINER, O., and FAIRLYER, G. H. Colorimetric, turbidity, and titration methods used in soil investigations. U. S. D. A. Bur. of Soils Bul. 31. 1906.
15. TRUE, R. H. The significance of calcium for higher green plants. Science 55: 1-6. 1922.

## SECTIONAL NOTES

### NEW YORK

The seed potato acreage entered for certification in New York is 15 per cent less than the acreage entered in 1932. The reduction is not shared equally by the four important varieties, as may be seen from the following figures:

<i>Variety</i>	<i>Acreage entered for Inspection</i>	
	<i>1932</i>	<i>1933</i>
Green Mountain .....	799	556
Smooth Rural .....	743	604
Russet Rural .....	633	509
Irish Cobbler .....	399	514
Miscellaneous .....	76	71

It is interesting to note that this year  $2\frac{1}{2}$  acres of Katahdins have been entered for certification.

The quantity of seed certified is expected to be less than last year, not only because of the smaller acreage, but also because of the drought which is quite general in central and western New York. In this section the yield of the early varieties has been irreparably reduced so that in spite of the increased acreage of Cobblers a considerable decrease in the quantity of this variety available for seed is anticipated. The effect of the drought has been to shorten the growing period and should have the effect of reducing the spread of the virus diseases. Another result of the lack of moisture has been the retarded appearance of early and late blight. There will be much small seed of excellent quality since the size will be the result of dry weather rather than disease. If weather conditions become favorable, the late varieties may still do well.

Yellow dwarf is the most serious disease with which the growers have to contend this year. Since 1930 there has been a steady increase of this trouble in certain localities and it is anticipated that in this region more fields will fail to pass inspections than in previous years.

Next to yellow dwarf in importance comes leafroll, and this disease is also much more disturbing in certain areas than in others. In some regions of the state very little trouble is being occasioned by either disease.

As far as insects are concerned, the most noticeable change is the general scarcity of the Colorado potato beetle. In many places it has been unnecessary to take control measures against the pest. There also seems to be less aphids and leaf hoppers than commonly is the case.—L. M. BLACK.

#### WISCONSIN

Present indications are that between 2000 and 2500 acres of potatoes have been entered for certification this year. This acreage will represent mainly the Triumph, Rural New Yorker, Irish Cobbler and Green Mountain varieties. Most of the seed producing areas in the upper half of the state have had adequate rains during the period from July 15 to July 25. The more favorable conditions as to rainfall and temperature have greatly improved the prospects as related to the certified seed outlook in upper Wisconsin.

The extreme heat and drought of early June in some sections of the state have resulted in poor stands, especially on some of the lighter sandy soils. Our certified seed growing areas are not located in these sections and we, therefore, believe conditions as related to certified seed production are much improved over the general potato crop prospects in the state.—J. G. MILWARD.

#### VERMONT

This year 481 acres have been entered for certification as compared with 684 in 1932. Approximately 81 per cent of the acreage is planted with the Green Mountain variety and 18 per cent with the Irish Cobbler. Three acres, planted with the Katahdin variety have been entered for certification. The quality of the seed used appears to have been good. The rate of application of fertilizer was reduced somewhat but not enough to affect general production. Up to date comparatively little mosaic has been found and there have been no extremely bad outbreaks of leafroll. Several strains of Green Mountains are showing extremely little disease.—H. L. BAILEY.

#### MAINE

The certification work is now well under way; twelve inspectors began field inspections on Wednesday, July 12. At the end of the week it was very evident that the proper time to make disease readings had been chosen. The week previous, mosaic counts were hard to get accurately but, on the above date, conditions were very favorable. Some of the fields were late planted but it looks now as though the first inspection would be completed by July 29. We have not had time to look over all the field reports but from available information

it seems as though there has been at least two sources of foundation stock developed on private farms. For the first time in several years we have a few plots on which no disease at all can be found. This stock was developed at Highmoor Farm in central Maine and distributed to several growers in Aroostook County. The writer was in a two-acre field last Thursday with three other people and was unable to locate any diseased plants. This is encouraging inasmuch as the raising of foundation Green Mountains seems to be a problem needing the attention of our potato men.—E. L. NEWDICK.

#### MINNESOTA

The month of June was, I believe, one of the hottest and driest on record. Although the hot, dry conditions extended throughout the entire state, I doubt if any damage was done in the Red River Valley or in the northeastern section of the state, as potatoes are usually planted during the latter part of May or early June in these regions.

However, the growers in the sand land area have suffered large losses. Potatoes are planted in this region during the month of April. The hot, dry weather hit the plants just about the time tuber formation started, and in the earliest fields planted, the crop is almost a total failure. Usually at this time digging is in full swing with the fields averaging around 200 bushels of good quality stock. At the present time 25 to 40 bushels of poor quality stock is the average. Since the month of July has been rather ideal for potato growing, it is entirely possible that those growers in the sand land section, who were lucky enough to have some late planted stock, might get more favorable returns.

As far as the certified seed crop is concerned, most of it is produced in the Red River Valley and the northeastern part of the state. What stock is planted for certification in the southern half of the state is on peat, planted late and will come out all right. We are inspecting a total of 4330 acres this year consisting mostly of Bliss Triumph, Early Ohio, and Irish Cobbler potatoes. The first field inspection has just about been completed and so far very few fields have fallen by the way side. In our field inspections we expect to get our best check on Mosaic during the first inspection, and the inspection records show that we will have stock quite free of Mosaic diseases. We have also been able, during the first inspection, to get a better check on spindle tuber than is usual at this time because of the advanced condition of the plants. Blackleg, which is most prevalent during wet seasons, will, I believe, be a minor factor this season as it has been during the last two years.

One of the worst pests the growers have had to contend with this year is the Colorado potato beetle, but most growers realizing better prospects with potatoes than for some years have gone after them with a vengeance.—A. G. TOLAAS.

## NORTH DAKOTA

It has been generally conceded among Southern potato men for quite a few years that the farther North their certified seed stock is grown, the better it will be. Just what makes this true was one of the main reasons for the Eighth Annual Far North Region Potato Tour held in the northeastern section of North Dakota, July 25 and 26.

The tour included visits to the potato territories of Fordville, Edinburg, Cavalier, Hoople, Grafton, and Park River. At the latter community new seed stock strains are being developed to meet the needs of the southern potato grower. For this development work healthy tuber unit seed stock is selected on a basis of the greatest number of desirable characteristics. Careful greenhouse indexing is done, in which an eye from each potato is tested for disease, to insure the seed stock getting a disease free start.

The seed stock is developed through the use of isolated tuber unit seed plots, gradually increasing the size of the plots from year to year, each season selecting that which looks the most promising. In this way, E. J. Taintor, secretary of the Far North Potato Association, points out, "A complete official history of each stage in the development of our certified seed stock is obtainable and is of much value in determining the conditions most suitable for its growth, from a standpoint of yield, hardiness, disease resistance, vitality, and early maturity." Strain 164, an early maturing Triumph, developed by H. D. Long, deputy in charge of the Northeastern Branch of the State Seed Department, is a most outstanding example of improvement work being carried on in that section of the country. This strain matures from 7 to 10 days earlier than the average Triumph potato.—EARL HUDGSON.

## PENNSYLVANIA

Certified seed potato crop prospects are not so good at this writing as they were last year. Most fields were planted just a little later than usual, due principally to the excessive amount of rainfall during May. The continued high temperatures during June, when most of the plants were coming through the ground, appear to have affected their vitality somewhat. Growing conditions during July were generally unfavorable because of dry weather. In most sections of the state the earlier-planted seed fields produced good stands, as a whole, but the later-planted fields resulted in rather poor stands.

Fields in Pennsylvania show less disease than they ever did. While we still find an occasional leafroll plant, this disease has been reduced to a point where it appears on our records as only a trace. Leafrolling mosaic seems to be our biggest problem and even this disease has been showing up in lesser amounts this year than formerly.

This year we have 622.75 acres entered for certification compared with 599.5 acres in 1932. The principal varieties certified are the Russet and White Rural with a few acres of Irish Cobblers.—K. W. LAUER.